Formule

$Q = 2^8 - 1 = 255$ nivoji sivine $\quad \triangle = \frac{U_{max} - U_{min}}{256}$

$P = [x, y, z] \quad P' = [x', y', z'] \quad z' = f' \quad \rightarrow \quad x' = f' * x/z \quad y' = f' * y/z$

$\frac{1}{z'} - \frac{1}{z} = \frac{1}{f}$ f je goriščna razdalja

notranji parametri: $\alpha, \beta, u_0, v_0, \theta \quad \rightarrow \quad p = \frac{1}{z} MP \quad M_{3\times 4} = [K, 0]$

$$K = \begin{bmatrix} \alpha & -\alpha \cot\theta & u_0 \\ 0 & \frac{\beta}{\sin\theta} & v_0 \\ 0 & 0 & 1 \end{bmatrix} \qquad p = [u, v, 1]^T \qquad P = [x, y, z, 1]$$

$\alpha = kf \quad \beta = lf$ k,l določata velikost piksla u_0, v_0 pa premik izhodišča koordinatnega sistema iz $C -> C_0$

zunanji parametri: $p = \frac{1}{z} MP \quad M_{3\times 4} = K[R, t] \quad R_{3\times 3}$ rotaciska matrika, $t_{3\times 1}$ stolpični vektor

$u = \frac{m_1 P}{m_3 P}$ in v $v = \frac{m_2 P}{m_3 P}$ $\quad m_i$ so vrstice matrike M

$$R_x = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\alpha & \sin\alpha \\ 0 & -\sin\alpha & \cos\alpha \end{bmatrix}, R_y = \begin{bmatrix} \cos\beta & 0 & -\sin\beta \\ 0 & 1 & 0 \\ \sin\beta & 0 & \cos\beta \end{bmatrix}, R_z = \begin{bmatrix} \cos\gamma & \sin\gamma & 0 \\ -\sin\gamma & \cos\gamma & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Kalibracija:$(m_1 - u_i m_3) P_i = 0$ in $(m_2 - v_i m_3) P_i = 0$

$$P_{2n\times 12} = \begin{bmatrix} P_1^T & 0^T & -u_1 P_1^T \\ 0^T & P_1^T & -v_1 P_1^T \\ \vdots & \vdots & \vdots \\ P_n^T & 0^T & -u_n P_n^T \\ 0^T & P_n^T & -v_n P_n^T \end{bmatrix} \text{ in } m_{12\times 1} = \begin{bmatrix} m_1^T \\ m_2^T \\ m_3^T \end{bmatrix} \text{ Rešit je treba:} P_m = 0_{2n\times 1}, M = \begin{bmatrix} m_1 \\ m_2 \\ m_3 \end{bmatrix}$$

Linearizacija: $g' = \frac{Q}{max - min}(g - min)$ kjer g' predstavlja novo sivino piksla max in min sta največji sivini v sliki, Q je max sivina transformacije

Histogram sivin: $h = [h_0, h_1, ..., h_Q]$, h_i št pikslov z enako sivino

izenačitev histograma : $g' = \frac{Q}{MN} \sum_{i=0}^{g} h_i \quad MN$ je st pikslov v sliki

prenosne funkcije: $g' = \frac{1}{16}\sqrt{g}$

sita: $H_{\text{nizko}} = \frac{1}{9}\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}, \quad H_{\text{visoko}} = \begin{bmatrix} 1 & -2 & 1 \\ -2 & 5 & -2 \\ 1 & -2 & 1 \end{bmatrix}$ Gauss: $G_\sigma = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$

za (i, j) ti element maske velikosti $(2k+1) \times (2k+1):\ H(i, j) = \frac{1}{2\pi\sigma^2} e^{-\frac{(i-k-1)^2 + (j-k-1)^2}{2\sigma^2}}$

detektor robov: $|\operatorname{grad} \mathcal{I}(x, y)| = \sqrt{\left(\frac{\partial \mathcal{I}}{\partial x}\right)^2 + \left(\frac{\partial \mathcal{I}}{\partial y}\right)^2}$ – velikost gradienta

$\psi = \arctan\left(\frac{\frac{\partial \mathcal{I}}{\partial y}}{\frac{\partial \mathcal{I}}{\partial x}}\right)$ – smer gradienta

$\frac{\partial I(i,j)}{\partial x} \approx \frac{I(i,j) - I(i-\Delta x, j)}{\Delta x} \quad - \text{razlika nazaj}$, $\frac{\partial I(i,j)}{\partial x} \approx \frac{I(i+\Delta x, j) - I(i,j)}{\Delta x} \quad - \text{razlika naprej}$, $\frac{\partial I(i,j)}{\partial x} \approx \frac{I(i+\Delta x, j) - I(i-\Delta x, j)}{2\Delta x} \quad - \text{simetrična razlika}$

Laplacov $H = \begin{bmatrix} 1 & 1 & 1 \\ 1 & -8 & 1 \\ 1 & 1 & 1 \end{bmatrix}$ **Sobelov**: $H_1 = \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix}, \quad H_2 = \begin{bmatrix} 1 & 0 & -1 \\ 2 & 0 & -2 \\ 1 & 0 & -1 \end{bmatrix}$

H_1 **horizontalni**, $H2$ **vertikalni**

$Y = I * H_1$ in $X = I * H_2$ **velikost roba:** $\sqrt{X^2 + Y^2}$ **smer roba**: $\arctan(\frac{Y}{X})$

segmentacija s **konstantnim** pragom T: $S(i, j) = \begin{cases} 1, & \text{if } I(i, j) \geq T \\ 0, & \text{else} \end{cases}$

segmentacija z **variablinim** pragom T: $S(i,j) = \begin{cases} 1, & \text{if } I(i,j) \geq T(i,j) \\ 0, & \text{else} \end{cases}$

Večpragovne: $S(i,j) = \begin{cases} 0, & \text{if } I(i,j) < T_1 \\ 1, & \text{if } T_1 \leq I(i,j) < T_2 \\ 2, & \text{if } T_2 \leq I(i,j) < T_3 \\ \vdots \\ n-1, & \text{if } T_{n-1} \leq I(i,j) < T_n \\ n, & \text{else} \end{cases}$

metode za pragove: $T = \frac{min+max}{2}$, $A_k = \sum_{i=0}^{k} h_i$, $B_k = \sum_{i=0}^{k} i h_i$, $A_Q = MN$ št pikslov sliki , $B_Q = \sum_i \sum_j I(i,j)$ vsota vseh sivin

$T_{MEAN} = \frac{B_Q}{A_Q}$, $T_{MEDIAN} = \frac{A_T}{A_Q} \approx 0.5$,

OPTIMAL: $\mu_{T_k} = \frac{B_{T_k}}{A_{T_k}} \quad \text{in} \quad \gamma_{T_k} = \frac{B_Q - B_{T_k}}{A_Q - A_{T_k}} \qquad T_{k+1} = \frac{\mu_{T_k} + \gamma_{T_k}}{2}$ zaključiš ko $|T_{k+1} - T_k| < \epsilon$

μ_{T_k} je povprečna sivina trenutnega ozadja γ_{T_k} povprečje trenutnega objekta(ov)

KAPUR: $\max_T \left(H_{\text{ozadje}}(T) + H_{\text{objekti}}(T)\right)$, $H_{\text{ozadje}}(T) = -\sum_{i=0}^{T} \frac{p_i}{P_T} \log \frac{p_i}{P_T}$, $H_{\text{objekti}}(T) = -\sum_{i=T+1}^{Q} \frac{p_i}{1-P_T} \log \frac{p_i}{1-P_T}$, $\mathbf{p} = \frac{1}{MN}\mathbf{h} \quad \text{in} \quad P_T = \sum_{i=0}^{T} p_i$, $\mathbf{p} = [p_0, p_1, \ldots, p_Q]$ – normaliziran histogram sivin

Ujemanje šablon: $C_1(i,j)$: $C_1(i,j) = \left(\max_{(u,v)\in\mathcal{H}} |I(i+u, j+v) - H(u,v)|\right)^{-1}$,

$C_2(i,j)$: $C_2(i,j) = \left(\sum_{(u,v)\in\mathcal{H}} |I(i+u, j+v) - H(u,v)|^p\right)^{-1} \quad \text{kjer} \quad p = \{1,2\}$

Zaporedje slik: $\mathcal{J} = \{I_0, I_1, \ldots, I_{K-1}\}$, $\mathcal{J} = \mathcal{I}(x,y,t)$ - za zvezne razmere

časovni interval med slikam: $t_{k+1} = t_k + \Delta t \quad \text{oz.} \quad t_{k+1} = t_0 + (k+1)\Delta t$

slike razlik: $\Delta I_k = I_{k+1} - I_k$, **pragovna operacija** $S(p) = \begin{cases} \text{gibajoči se}, & \text{if } |\Delta I_k(p)| \geq T \\ 0, & \text{else} \end{cases}$

statično ozadje: $\Delta I_k = I_k - I_{\text{ozadje}}$, ΔI_k (abs) določa področje velikih sprememb

Optični pretok: $\mathbf{U}(p) = [u_x, u_y]$ - za koliko se je premaknil vsak piksel

$\frac{d\mathcal{I}}{dt} = 0 \quad \text{oz.} \quad [\mathcal{I}_x, \mathcal{I}_y] \begin{bmatrix} u_x \\ u_y \end{bmatrix} + \mathcal{I}_t = 0$, $\mathcal{I}_x$ in $\mathcal{I}_y$ - prostorska odvoda , $\mathcal{I}_t$ časovni odvod

$\mathbf{A} = \begin{bmatrix} \mathcal{I}_x(\mathbf{p_1}) & \mathcal{I}_y(\mathbf{p_1}) \\ \mathcal{I}_x(\mathbf{p_2}) & \mathcal{I}_y(\mathbf{p_2}) \\ \vdots & \vdots \\ \mathcal{I}_x(\mathbf{p_Q}) & \mathcal{I}_y(\mathbf{p_Q}) \end{bmatrix} \quad \text{in} \quad \mathbf{b} = \begin{bmatrix} \mathcal{I}_t(\mathbf{p_1}) \\ \mathcal{I}_t(\mathbf{p_2}) \\ \vdots \\ \mathcal{I}_t(\mathbf{p_Q}) \end{bmatrix}$, $\underbrace{\mathbf{u}}_{2\times 1} = \begin{bmatrix} u_x \\ u_y \end{bmatrix} 2 \times 1 = -\underbrace{\mathbf{A}^{-g}}\underbrace{\mathbf{b}}_{2 \times QQ \times 1}$ kjer je

$A^{-g} = (A^T A)^{-1} A^T$